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(71) Applicant *(for all designated States except US)*: **THOMSON LICENSING S.A.** [FR/FR]; 46, quai A. le Gallo, F-92100 Boulogne-Billancourt (FR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ELSÄSSER, Alexander** [DE/DE]; Warenburgstr. 38, 78050 Villingen-Schwenningen (DE). **SUZUKI, Tsuneo** [JP/DE]; Sportplatzweg 1, 78087 Mönchweiler (DE).

(74) Agent: **KURTH, Dieter**; Deutsche Thomson-Brandt GmbH, European Patent Operations, Karl-Wiechert-Allee 74, 30625 Hannover (DE).

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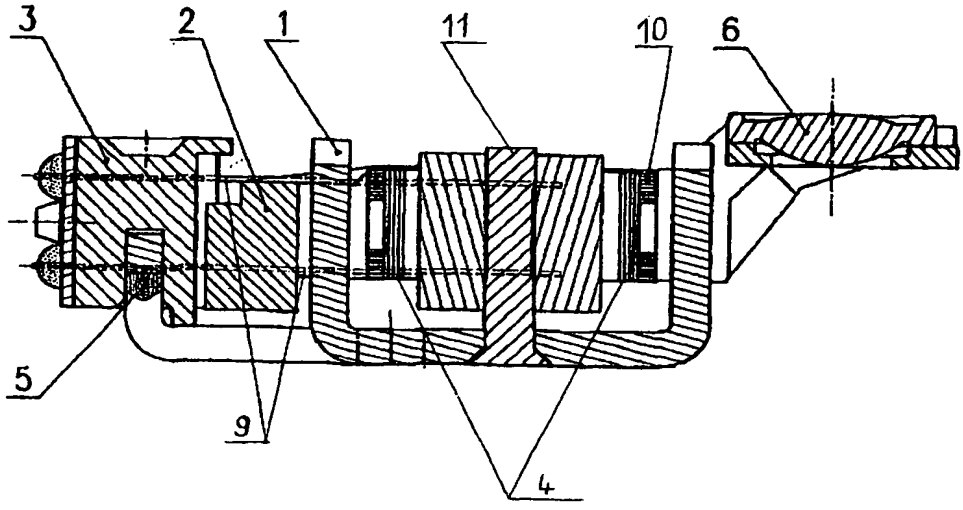
(54) Title: ACTUATOR FOR A PICK-UP IN AN APPARATUS FOR THE OPTICAL RECORDING OR REPRODUCTION OF INFORMATION



(57) Abstract: The invention relates to an actuator for a pick-up in an apparatus for the optical recording or reproduction of information with a high dynamic range in conjunction with a low power consumption, which, moreover, can be realized with a small structural height. It is an object of the invention to eliminate the disadvantages of asymmetrical actuators and to provide an actuator having comparatively higher sensitivity and a better dynamic behaviour, which can be embodied with a small structural height. The invention is based on the principle that an asymmetrical actuator is provided which has two magnetic chambers which are arranged one behind the other and in which, with a current flowing in coils, forces are generated outside the centre of gravity of the actuator, but their undesirable torques compensate one another. The invention can preferably be applied to asymmetrical actuators for optical scanning devices in CD and DVD and also computer apparatuses.

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Actuator for a pick-up in an apparatus for the optical recording or reproduction of information

The invention relates to an actuator for a pick-up in an apparatus for the optical recording or reproduction of information with a high dynamic range in conjunction with a low power consumption for CD and DVD and also computer applications, which, moreover, can be realized with a small structural height.

In principle, it is possible to distinguish between symmetrical actuators, asymmetrical actuators and so-called rotary actuators. Actuators having a symmetrical construction are characterized in that the focus or objective lens is arranged in the centre of the drive system. Actuators having an asymmetrical construction are characterized in that the focus lens is arranged outside the centre of the drive system, and the rotary actuator, also referred to as shaft actuator, is characterized in that the objective lens, in the event of deflection in the track direction, executes a rotary movement about an axis of rotation.

The present invention is concerned, in particular, with an actuator having an asymmetrical construction, as is disclosed for example in JP 11-203697. Previously known actuators for planar pick-ups have, in the case of a horizontal installation position of the drive for vertical deflection of the objective lens, a focus coil and a coil pair for horizontal deflection in the track direction, the permanent magnetic field in which the coils are arranged being generated by at least one magnet. It is disadvantageous that asymmetrical actuators, in which the objective lens is arranged outside the centre of the drive system, in comparison with symmetrical and rotary actuators, have a low sensitivity and a poorer dynamic behaviour and also only require a larger structural height.

It is an object of the invention to eliminate the disadvantages of asymmetrical actuators and to provide an actuator having comparatively higher sensitivity and a better dynamic behaviour, which can be embodied with a small structural height.

This object is achieved by means of the features specified in independent claims. Advantageous designs and developments are specified in dependent claims.

One aspect of the invention involves utilizing the static magnetic field, which is generated by at least one magnet, consistently to obtain a higher sensitivity and a better dynamic behaviour of an optical recording or reproduction system. In known asymmetrical actuators, for example, half of the focus coil is not utilized, since it lies outside the static magnetic field. A further aspect of the invention involves ensuring, despite forces generated outside the centre of gravity of the actuator, for deflecting the actuator from a rest position, exact parallel guidance of the objective lens in two mutually perpendicular directions of movement, which are not intended to influence one another.

An asymmetrical actuator is provided which has two magnetic chambers which are arranged one behind the other and in which, with a current flowing in coils, forces are generated outside the centre of gravity of the actuator, but their torques compensate one another.

For this purpose, coils are arranged in a system comprising magnetic yoke and magnets in such a way that two sides of the coil are situated within a magnetic field formed with two magnets.

In the case of an asymmetrical actuator, it must be ensured that a force generated by the current in a coil in the static magnetic field acts exactly in the centre of gravity of the actuator. If this condition is not

satisfied, this force, with the distance from the centre of gravity, causes a torque which leads to the excitation of undesirable reciprocating movements and secondary resonances of the actuator which adversely affect the dynamic behaviour of the actuator. Therefore, known asymmetrical actuators are configured in such a way that the centre of gravity is situated in the region of the tracking coil pair arranged in a magnetic chamber.

The assymetrical actuator having two magnetic chambers arranged one behind the other is formed with a yoke comprising two U-shaped chambers made of magnetically permeable material which preferably have a common limb. Magnets for generating the static magnetic field are preferably arranged on the inner sides of the U-shaped chambers either on the common limb or on the limbs that are not shared. Arranging the magnets on the outer limbs of the chambers advantageously makes it possible to reduce the side length of the focus coil. Arranged in a manner descending into the two magnetic chambers are a focus coil, and, on the focus coil, respective tracking coils opposite limbs of the yoke, which are used to deflect an asymmetrical lens holder. What is proposed is an asymmetrical actuator with a drive system having drive means arranged outside the centre of gravity. Symmetrical forces which are generated outside the centre of gravity of the lens holder advantageously cancel one another out, however, with regard to torques generated by them and, on the other hand, are added for the deflection of the lens holder. The actuator or the lens holder with the coil system is preferably configured in such a way that the centre of gravity is situated in the centre or in the inner region of the focus coil. The fact that the coils are provided on the lens holder in a manner descending into two magnetic chambers means that both a high sensitivity and a better dynamic behaviour are achieved. The focus coil descends into a static magnetic field on both sides, with the result that both halves of the focus

coil are utilized and force generation which is symmetrical with respect to the centre of gravity and, moreover, counteracts displacement of the centre of gravity ensures a stable dynamic behaviour. The structural height of the actuator can be reduced by virtue of the higher sensitivity resulting in an advantageous application of the actuator in optical scanning devices for the recording or reproduction of information for mobile computers, also referred to as laptops.

By virtue of the fact that the forces for deflecting the lens holder act on two points, a disadvantageous flexure of the asymmetrical lens holder is reduced both in the focus direction and in the track direction.

A sheet made of magnetically permeable material covering the chambers of the magnetic yoke results in a further reduction in a magnetic leakage flux and a further increase in the sensitivity of the actuator. Furthermore, it is provided that a leakage flux bridge formed by the sheet forms a mechanical stop for the actuator, in order, for example in the case of a lens holder suspended on wires, to prevent its suspension from being damaged or deformed by excessive deflection or contact. The sheet for reducing the magnetic leakage flux furthermore has the advantage that it is made more difficult for objects that are extraneous to the actuator to penetrate into the actuator space and impede the function of the actuator.

Despite an asymmetrical actuator arrangement and with forces generated outside the centre of gravity, an optical scanning system is provided which has a small structural height, high sensitivity and stable dynamic properties.

The invention is explained in more detail below with reference to drawings, in which

Figure 1 shows a diagrammatic sketch of a known asymmetrical apparatus

Figure 2 shows a diagrammatic sketch of an asymmetrical actuator with two magnetic chambers

Figure 3 shows a diagrammatic sketch concerning the asymmetrical two-chamber actuator with a leakage-flux sheet

Figure 4 shows a diagrammatic sketch concerning the asymmetrical two-chamber actuator with magnets arranged on the outer limbs

Figure 5 shows a sectional illustration of the asymmetrical two-chamber actuator, and

Figure 6 shows a sketch of the asymmetrical two-chamber actuator in plan view.

Reference symbols are used in a corresponding fashion in the drawings.

The diagrammatic sketch - illustrated in Figure 1 - of a known asymmetrical actuator shows a focus coil 4 which, on one side, descends into a magnetic chamber formed by a U-shaped yoke 13 with magnets 8 arranged on the inner sides of the limbs of the U-shaped yoke 13. With the focus coil 4, which is connected to an objective lens 6 in a manner not illustrated, the objective lens 6 is oriented in the direction of a recording medium (not illustrated), in such a way that a scanning or writing beam directed onto the recording medium in an apparatus for the optical recording or reproduction of information is focused. For the tracking of the scanning or writing beam on the recording medium, tracking coils 10 are provided, which are arranged in a region on the focus coil 4 which is situated within the magnetic chamber in the region of the tracking coils 10. A magnetic field generated by the coils forms the drive system of the actuator, with which the objective lens 6 is deflected from a rest position in the track or focus direction. The objective lens 6 is arranged asymmetrically with respect to the drive system of the actuator.

As illustrated in Figure 1, half of the focus coil 4 is situated outside the magnetic chamber formed by the yoke 13 with the magnets 8, with the result that a magnetic field formed by this section of the focus coil 4 remains essentially unutilized for drive purposes. In comparison with symmetrical or rotary actuators, an asymmetrical actuator has a lower sensitivity since the efficiency of the magnetic field used as drive means is lower. In order to achieve a comparable sensitivity to symmetrical or rotary actuators, it is necessary, therefore, to provide higher coil currents and a larger structural height.

In the case of a known actuator in accordance with Figure 1, care must be taken rigorously to ensure that the forces generated by the coil current in the coils situated in a static magnetic field act exactly in the centre of gravity of the actuator in the focus direction and also in the track direction. Known asymmetrical actuators in accordance with Figure 1 are therefore configured in such a way that the centre of gravity is situated in the region of the point where the tracking coils 10 are connected to the focus coil 4. If this condition is not satisfied, a torque is produced by this force and the distance thereof from the centre of gravity, which torque leads to the excitation of undesirable reciprocating movements or secondary resonances of the actuator. Reciprocating movements or secondary resonances about an x-axis X are also brought about by a current that varies in the focus coil 4, and, about a z-axis Z, by a current that varies in the tracking coils 10. Driving in the focus or track direction thus adversely affects a perpendicular orientation of the scanning or writing beam onto the recording medium and leads to undesirable resonance phenomena which impair the dynamic behaviour of the pick-up.

In order to avoid the disadvantages of asymmetrical actuators, an asymmetrical two-chamber actuator is provided, which is illustrated as a diagrammatic sketch

in Figure 2 and has force generating means arranged outside its centre of gravity and nevertheless has a higher sensitivity, improved dynamic behaviour and a smaller required structural height. This is achieved by virtue of the fact that a symmetrical drive system is provided for the asymmetrical actuator, which drive system is formed with two magnetic chambers which are arranged one behind the other in the direction of the objective lens 6 and in which both a focus coil 4 and tracking coils 10 are arranged such that they descend symmetrically therein. The coil arrangement is connected to the objective lens 6 by means of an objective lens holder (not illustrated in Figure 2), the said objective lens holder being supported on a wire holder 3, connected to the yoke 1 of the actuator, by means of a compliant support 9 illustrated in Figures 5 and 6. In accordance with the embodiment illustrated in Figures 5 and 6, the compliant support 9 is formed by wires which are clamped in the wire holder 3 and connected to the objective lens holder by a fixing means 12 illustrated in Figure 6. Since the wires provided as the compliant support 9 are simultaneously used for supplying power to the coils, soldering tin is provided as fixing means 12. The objective lens 6 is fixed with an objective lens holding ring 7 on the lens holder and the lens holder preferably has a centre-of-gravity compensating element 2. However, the use of other fixing means 12, means for the compliant support 9 and power supply means and also other configurations does not affect the essence of the asymmetrical two-chamber actuator having two magnetic chambers arranged one behind the other in the direction of the objective lens 6. An asymmetrical two-chamber actuator illustrated in Figures 2 to 6 is formed with a yoke 1 comprising two U-shaped chambers made of magnetically permeable material which are arranged one behind the other in the direction of the objective lens 6. The chambers preferably have a common limb 11, which separates the chambers from one another. This common limb

11 is preferably formed by a web made of magnetically permeable material which divides a U-shaped yoke 1 into two chambers. As illustrated in Figure 5, the web forming the common limb 11 has a conical chamfer produced by caulking or riveting in the bottom of the U-shaped yoke 1 for the purpose of fixing the web. Proceeding laterally from the bottom of the U-shaped body which forms the yoke 1, wire holder connecting elements 5 are provided, which are formed by angular webs. The yoke 1 and the wire holder connecting elements 5 are preferably fabricated from one piece and mounting of the wire holder 3 is provided by plugging the wire holder 3 onto the wire holder connecting elements 5. The wire holder 3 accommodates the compliant support 9 for the lens holder, which bears the coil system for deflecting the actuator.

The coil system comprising focus coil 4 and tracking coils 10 is arranged in such a way that the focus coil 4 projects into both chambers of the two-chamber actuator. In this case, it descends completely into these chambers and is at a distance from the walls of the chambers which suffices for deflection of the actuator. In accordance with the embodiment illustrated in Figures 2 to 6, in each case two pairs of tracking coils 10 are arranged on the focus coil 4 and opposite the outer limbs of the yoke 1. This arrangement of the tracking coils 10 is advantageous for forming a symmetrical drive system with drive forces generated outside the centre of gravity, although an embodiment with only one tracking coil 10 is also possible. The coils - wound in opposite senses - of a coil pair of the tracking coils 10 effect lateral deflection of the actuator, which deflection is used for tracking and is guided with a parallel guide formed by the compliant support 9. In the case of a symmetrical drive system for the asymmetrical actuator, torques generated by forces acting outside the centre of gravity cancel one another out, thereby reducing reciprocal

influencing of the different directions of movement of the actuator.

The actuator is preferably formed in such a way that the centre of gravity of the actuator or of the system formed by the lens holder with the objective lens 6 and the coil system is situated in the mid-point of the focus coil 4. A centre-of-gravity compensating element 2, which is a component part of the lens holder, is provided for this purpose, as illustrated in Figure 5.

The tracking coils 10 form a drive system which is arranged outside the centre of gravity of the asymmetrical actuator, and, nevertheless, a pick-up or optical scanning system which does not have the disadvantages of known asymmetrical actuators is provided by virtue of the preferably symmetrical configuration of the drive system for the asymmetrical actuator. The fact that the focus coil 4 is arranged on both sides in the static magnetic field formed by the two chambers results in a higher sensitivity in the focus direction and, with the additional tracking coils 10 in the second chamber, also in the track direction. The current required for a comparable deflection is lower and coils and mechanical elements having smaller dimensions are used, with the result that a smaller structural height is achieved.

What is advantageously achieved with a symmetrical configuration of the drive unit is that torques based on changes in the currents flowing in the coils are directed in such a way that they cancel one another out. As a result, the asymmetrical two-chamber actuator has a better dynamic behaviour, manifested in the uniformity of the response behaviour, the avoidance of resonant increases and less reciprocal influencing of the different directions of movement of the actuator.

In order to generate the static magnetic field of the asymmetrical two-chamber actuator, magnets 8 are provided which, in accordance with the embodiment illustrated in Figures 2, 3, 5 and 6, are arranged on both sides of the common limb 11 of the yoke 1.

Figure 4 furthermore illustrates an embodiment in which the magnets 8 are arranged on the inner walls of the outer limbs of the yoke 1 formed with two chambers. An embodiment of this type advantageously reduces the side length of the focus coil 4 and thus the length of wire required for the focus coil 4 given the same number of turns.

In principle, it is also possible to have an embodiment in which magnets 8 are arranged in a manner distributed over all the limbs of the yoke 1 formed with two chambers.

In the exemplary embodiment illustrated in Figure 3 there is arranged, extending over both chambers of the yoke 1, a sheet made of magnetically permeable material, which forms a leakage flux bridge 14. The leakage flux bridge 14 reduces the magnetic leakage flux above the yoke 1 and increases the magnetic field line density in the air gap with respect to the limbs of the yoke 1, thereby further increasing the sensitivity of the actuator.
Furthermore, the leakage flux bridge 14 performs the function of a mechanical stop in order to prevent the compliant support 9 of the actuator from being damaged or deformed in the event of excessive deflection or by contact. Furthermore, objects that are extraneous to the actuator are prevented from getting into the actuator and impeding its function. In particular, the ingress of ferromagnetic objects which are extraneous to the actuator and are attracted by the magnet in the chambers is prevented.

The embodiments of the invention that are described here are specified only by way of example. On the basis of the teaching according to the invention, a person skilled in the art can realize other embodiments of an asymmetrical two-chamber actuator which remain within the scope of the invention.

Patent Claims

1. Actuator for a pick-up in an apparatus for the optical recording or reproduction of information, **characterized in that** the actuator is an asymmetrical actuator having a drive system arranged outside its centre of gravity.

2. Actuator according to Claim 1, **characterized in that** the asymmetrical actuator has a yoke (1) comprising two magnetic chambers, in which a coil system forming the drive system of the actuator is arranged.

3. Actuator according to Claim 2, **characterized in that** the chambers of the yoke (1) are arranged one behind the other in the direction of an objective lens (6).

4. Actuator according to Claim 2, **characterized in that** the chambers are embodied in a U-shaped manner and have a common limb (11).

5. Actuator according to Claim 2, **characterized in that** the magnetic chambers are composed of magnetically permeable material and are formed with magnets (8) arranged on a wall common to the two chambers.

6. Actuator according to Claim 2, **characterized in that** the magnetic chambers are composed of magnetically permeable material and are formed with magnets (8) arranged on the inner sides of the outer limbs of the chambers.

7. Actuator according to Claim 2, **characterized in that** the magnetic chambers of the yoke (1) are closed off with a leakage flux bridge (14).

8. Actuator according to Claim 7, **characterized in that** the leakage flux bridge (14) forms a mechanical stop for preventing excessive deflection of the actuator and a cover for preventing objects that are extraneous to the actuator from penetrating into the actuator.

9. Actuator according to Claim 1, **characterized in that** the asymmetrical actuator has a centre of gravity corresponding to the centre of its focus coil (4).

10. Actuator according to Claim 1, **characterized in that** the drive system is formed with a focus coil (4) which descends into two magnetic chambers and on which tracking coils (10) are arranged.

11. Actuator according to Claim 10, **characterized in that** a respective pair of tracking coils (10) on the focus coil (4) is arranged opposite an outer limb of the yoke (1) comprising two chambers.

12. Actuator according to Claim 1, **characterized in that** the drive system of the actuator is a yoke (1) which comprises two magnetic chambers and whose chambers are formed with a web fixed in a recess in the bottom of a U-shaped yoke (1).

13. Actuator according to Claim 12, **characterized in that** wire holder connecting elements (5) are provided which extend from the bottom of the U-shaped yoke (1) and are formed with angular webs which are produced in one piece with the U-shaped yoke (1).

14. Actuator according to Claim 1, **characterized in that** the drive system has a focus coil (4) in whose inner region is arranged a limb (11) which is common to two magnetic chambers and which is connected to

outer limbs on whose inner side magnets (8) are arranged.

15. Actuator according to Claim 10, **characterized in that** the asymmetrical actuator has a centre of gravity which corresponds to a line of symmetry formed by pairs of tracking coils (10).

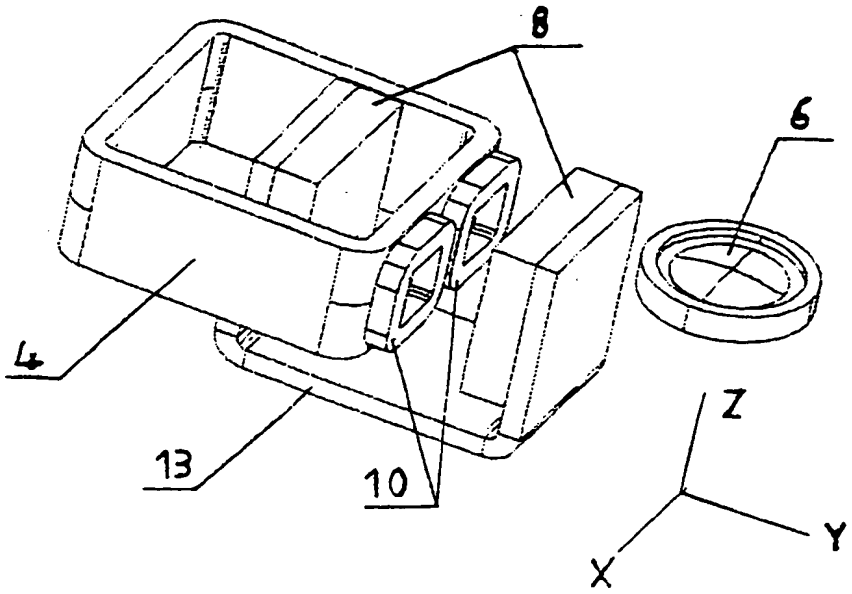

Fig. 1

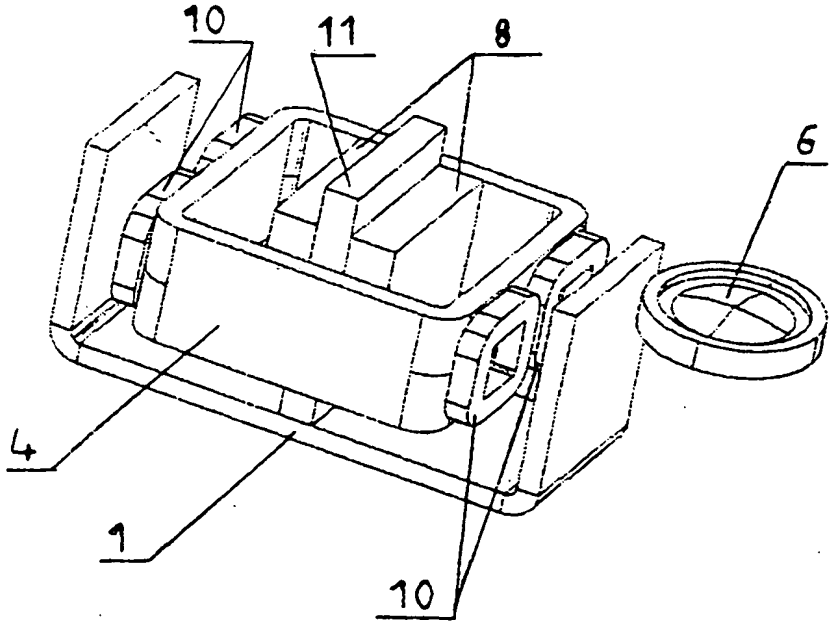

Fig. 2

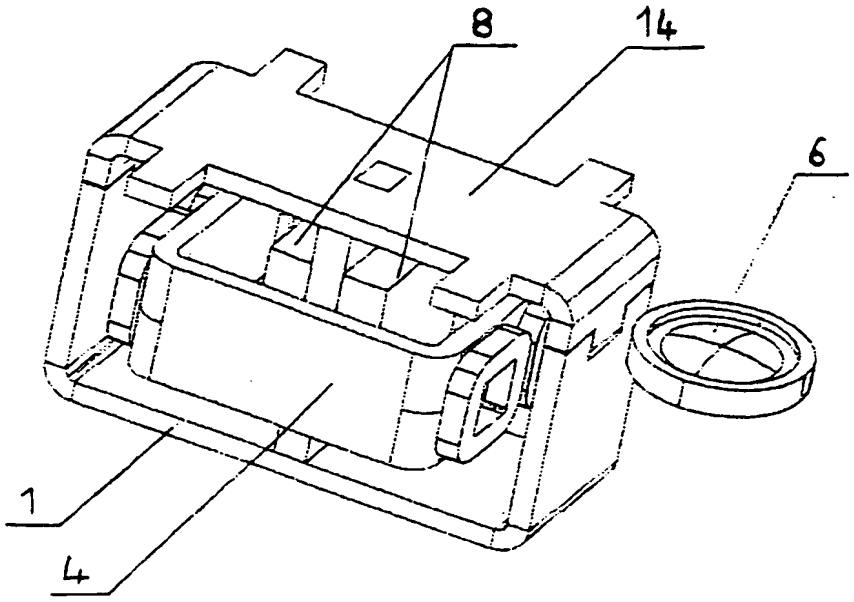

Fig. 3

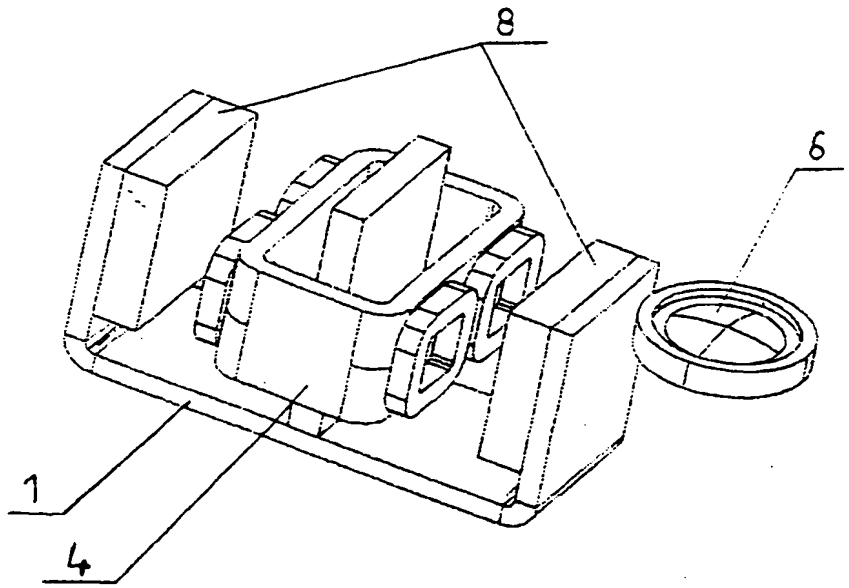

Fig. 4

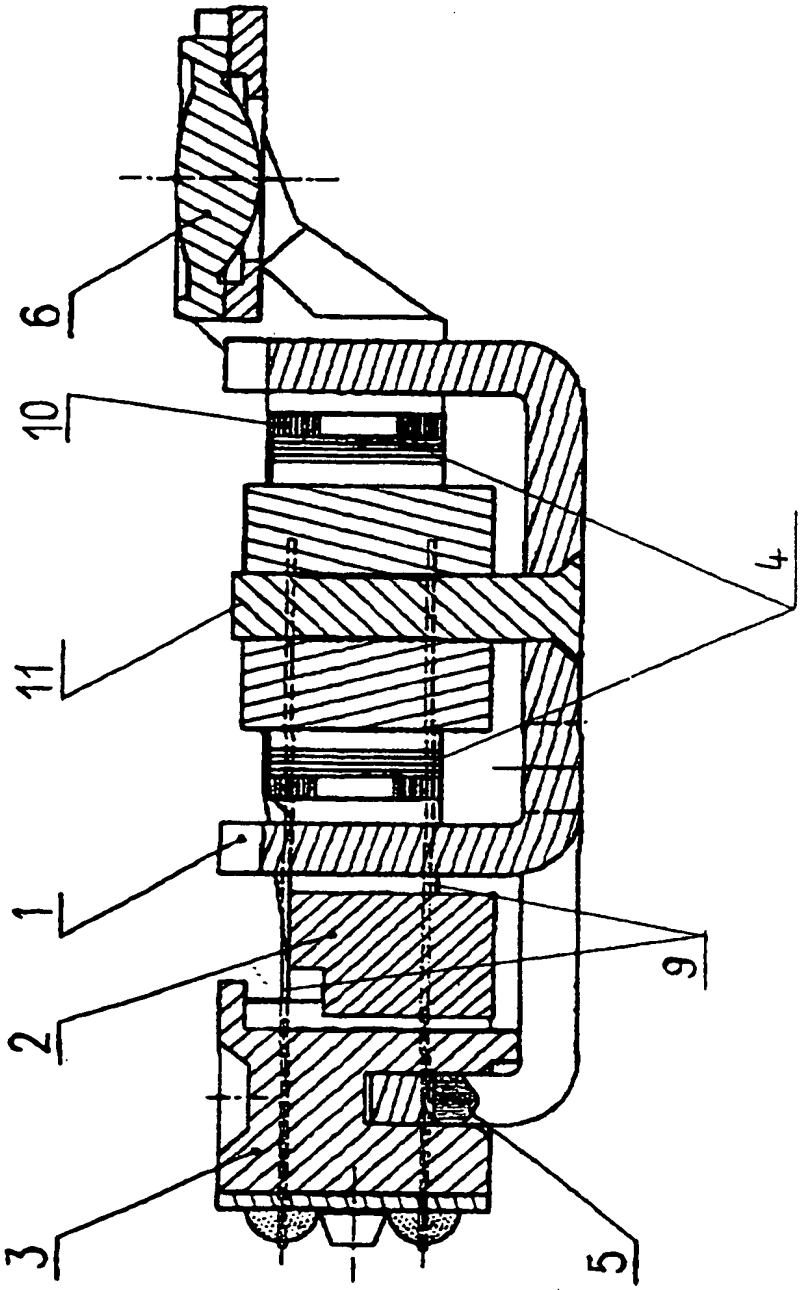

Fig. 5

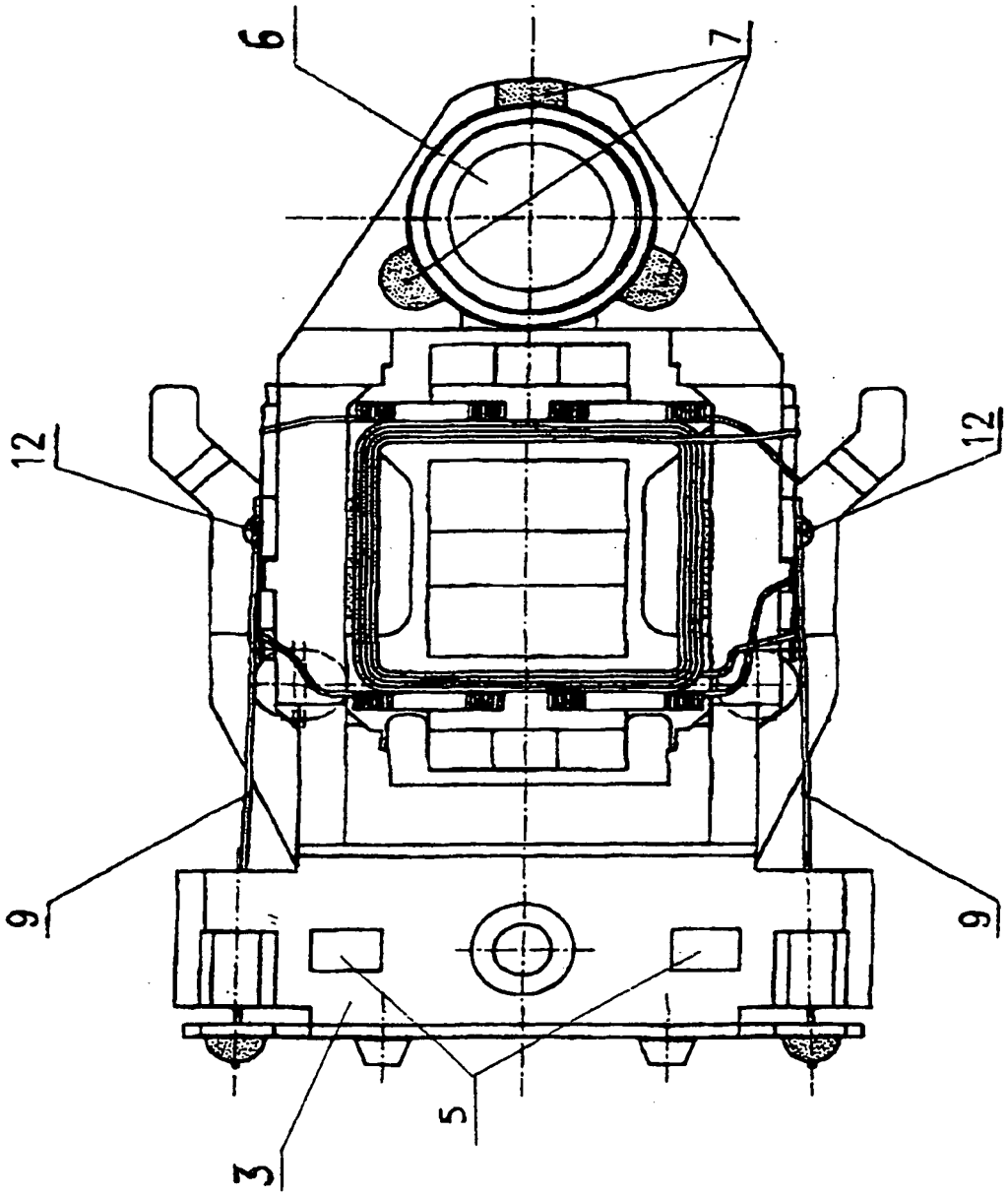

Fig. 6

INTERNATIONAL SEARCH REPORT

Ir tional Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B7/09

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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P,X	-& US 6 212 140 B1 (KIMURA ET AL.) 3 April 2001 (2001-04-03) column 5, line 32 - line 67; figure 6	1-4,6, 10,11,14
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 May 2002	10/05/2002

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INTERNATIONAL SEARCH REPORT

Ir ~ ational Application No
PCT/EP 01/15367

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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